

CLAIMS

What is claimed is:

1. An actuator having a recessed, movable electrode, the actuator comprising:
 - (a) a substrate including a stationary electrode attached thereto;
 - 5 (b) a resilient structural layer including a first end fixed with respect to the substrate, a second end suspended over the substrate, and a surface having a recess formed therein; and
 - (c) a movable electrode attached within the recess whereby the movable electrode is separated from the stationary electrode by a gap.
- 10 2. The actuator of claim 1, wherein the movable electrode is attached within the recess of the resilient structural layer whereby a portion of the resilient structural layer is separated from the substrate by a distance less than the movable electrode.
- 15 3. A microscale, electrostatically actuated switch having a recessed, movable electrode, the switch comprising:
 - (a) a substrate including a stationary electrode and a stationary contact attached thereto;
 - (b) a resilient structural layer including a first end fixed with respect to the substrate, a second end suspended over the substrate, and a surface having
20 a recess formed therein;
 - (c) a movable electrode attached within the recess whereby the movable electrode is separated from the stationary electrode by a first gap; and

(d) a movable contact attached to the structural layer whereby the movable contact is separated from the stationary electrode by a second gap.

4. The actuator of claim 3, wherein the movable electrode is attached at the underside of the recess of the resilient structural layer whereby a portion of the resilient structural layer is separated from the substrate by a distance less than the movable electrode.

5. A method of implementing an actuation function in an actuator having a recessed, movable electrode, comprising the steps of:

(a) providing an actuator having a recessed, movable electrode, the actuator comprising:

(i) a substrate including a stationary electrode attached thereto;

(ii) a resilient structural layer including a first end fixed with respect to the substrate, a second end suspended over the substrate, and a surface having a recess formed therein; and

(iii) a movable electrode attached at the underside of the recess whereby the movable electrode is separated from the stationary electrode by a gap;

(b) applying a voltage between the stationary electrode and the movable electrode to electrostatically couple the movable electrode with the stationary electrode across the gap, whereby the resilient structural layer is deflected towards the substrate.

6. A method for fabricating an actuator having a recessed, movable electrode, comprising the steps of:

- (a) forming a stationary electrode on a substrate;
- 5 (b) depositing a first sacrificial layer on the stationary electrode and the substrate;
- (c) depositing a second sacrificial layer on the first sacrificial layer;
- (d) patterning a portion of the second sacrificial layer to the first sacrificial layer;
- 10 (e) forming a movable electrode at least partially in the patterned portion of the second sacrificial layer;
- (e) depositing a structural layer on the first sacrificial layer, the second sacrificial layer, and the movable electrode;
- (f) removing a sufficient amount of the first and second sacrificial layers so as
- 15 to separate the movable electrode from the substrate, wherein the structural layer is supported by the substrate at a first end and is freely suspended above the substrate at an opposing second end.

7. A method for fabricating microscale, electrostatically actuated switch having a recessed, movable electrode, comprising the steps of:

- 20 (a) forming a stationary electrode and a stationary contact on a substrate;
- (b) depositing a first sacrificial layer on the stationary electrode, the stationary contact, and the substrate;

- (c) depositing a second sacrificial layer on the first sacrificial layer;
- (d) patterning a first portion of the second sacrificial layer to the first sacrificial layer;
- (e) forming a movable electrode at least partially in the patterned first portion of the second sacrificial layer;
- (f) patterning a second portion of the second sacrificial layer to the first sacrificial layer;
- (g) forming a movable contact at least partially in the second portion of the patterned second sacrificial layer;
- (f) depositing a structural layer on the first sacrificial layer, the second sacrificial layer, the movable electrode, and the movable contact;
- (g) removing a sufficient amount of the first and second sacrificial layers so as to separate the movable electrode and the movable contact from the substrate, wherein the structural layer is supported by the substrate at a first end and is freely suspended above the substrate at an opposing second end.